Proceedings of the Iowa Academy of Science

Volume 27 | Annual Issue Article 62

1920

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A BIOLOGICAL RECONNAISSANCE OF THE OKEFINOKEE SWAMP IN GEORGIA: THE FISHES

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From the earliest days of North American ichthyology to the present the fishes of South Carolina and North Carolina have received particular attention and in more recent times according to one author [6] Florida fishes have attracted more general interest than those of any other state in the Union. Georgia forms by contrast have received scant attention and often have come into ichthyologic literature by inclusion in the range of northern species known from Florida or of southern species known from South Carolina and northward.

The only ichthyologist who is associated in literature with Okefinokee swamp is Charles H. Bollman.[10] In the latter part of June, 1889, he with Mr. Bert Fesler explored some of the lowland streams of Georgia and as the result of this trip lost his life. He spent most of his time at Savannah, at Waynesborough and at Millen on Ogeechee river, quite remote from the Okefinokee swamp. He spent a day or so at Waycross on Satilla river but it is doubtful if he entered the Okefinokee swamp proper. Some distance southeast of Waycross is the Little Okefinokee swamp, a tributary of Satilla river, but there is no evidence that he visited it. Jordan and Evermann [18] in speaking of *Chologaster cornutus* gives the following notation: "Gilbert. Bull. U. S. Fish Commission, VIII, 1888, 227, specimens from Okefinokee Swamp, Millen, Ga.; caudal fin more dusky, with little white at base." First of all only one specimen was taken and secondly this was secured at Millen, Georgia, one hundred or more miles north of the swamp.

The record that *Notropis roseus* [18] is "the commonest species in the Okefinokee swamps" is based on captures at Waycross and might possibly pass unchallenged yet it is hardly in Okefinokee swamp proper. But the hardest blow for a zealous lover of the Okefinokee is Dr. Jordan's statement that [16] "Charles Henry Bollman (1868-89) (was) stricken with fever in the Okefinokee Swamps in Georgia." The evidence from Dr. Gilbert's paper does not show it nor does he claim it but of

course this does not preclude a trip of which no written record is made. Our party (1912) of thirteen was in the heart of the swamp for six weeks with no fever contracted thereafter and our record accords with the experiences of the Thompson brothers in Civil War times, with those of the surveying parties of 1879, and with those of the Harper brothers (1902-17).

In 1894 Dr. Einar Loennberg [20] compares the source of the marine and fluviatile elements in the ichthyfauna of Forida as follows: "From this it is thus evident that in the marine fishfauna of Florida the tropical components really are ruling. But this is not the case in regard to the 'ichthys' of the freshwater. If we completely omit all marine fishes, which not few in number, ascend streams and rivers and sometimes penetrate deep into the country, we can divide the real fresh-water fishes of Florida into two classes. 1) Fishes with wide distribution and which can be found far north from Florida. To this belong Lepidosteus, Amia, most of the catfishes, Erimyzon, Notemigonus, Dorosoma, the eel, Esox reticulatus, Labidesthes, Pomoxys, Chaenobryttus, Enneacanthus, Lepomis pallidus and Micropterus. Some other ones do not extend so far north, but go at least to South Carolina, as Zygonectes chrysotus, Gambusia, Girardinus and Lepomis holbrooki. All in all this class will embrace about a quarter of a hundred. The second class should include the typical Floridafishes, but they are only half as many. To them belong Amiurus erebennus, Jordanella, Fundulus seminolis and F. ocellaris, Zygonectes henshalli and craticula, Lucania goodei, Elassoma evergladei, Lepomis punctatus and mystalis. A few are found in Florida and also in Georgia as Notropis roseus, Etheostoma quiescens. Molliensia latipinna extends westward to Mexico and Lepidosteus tristaechus southward to Cuba and Central America. As this second class however is not but about half as large as the first, the fresh water fauna of Florida with respect to the fishes can be said to have originated from the North and is thus not tropical. This is the more the case as most of even these freshwater fishes that are typical for Florida have relatives belonging to the same genera in other parts of North America."

At present there are few freshwater fishes which might be termed strictly Floridan, to wit:—*Jordanella floridae, Lucania goodei, Fundulus seminolis, Fundulus henshalli and Ameiurus erebennus* (the latter probably synonomous with *Ameiurus natalis* and not so important in this discussion).

In this connection it is interesting to note two casual collections

of predominant fishes made by Francis Harper in January, 1917. On the prairies of the Okefinokee in one collection (Jan. 14, 1917) he secured *Lucania ommata, Fundulus chrysotus, Fundulus nottii* and *Gambusia affinis* in quantity and *Enneacanthus*. Later in a small random collection taken at Lake Tohopekaliga, Kissimmee, Florida, January 29, 1917, he took *Jordanella floridae, Lucania goodei, Fundulus seminolis* of the so called typical Florida fish, also *Molliensia latipinna, Heterandria formosa, Gambusia affinis* and *Enneacanthus gloriosus*. *Heterandria formosa* extends from North Carolina to Florida and *Molliensia latipinna* from South Carolina to Mexico. Both must be too brackish to enter the Okefinokee. One cannot resist the suggestion that the *Jordanella floridae, L. goodei, F. seminolis* and *F. henshalli,* associates of the above two brackish species, may be also somewhat brackish and too much so for the Okefinokee.

Many of these same characteristic forms of Florida appear to the north and east along the east coast under more brackish conditions, namely at Indian river and Lake Jessup. Among them are [14] *Jordanella floridae, Fundulus seminolis, Fundulus henshalli* and *Molliensia latipinna*. Woolman [23] found *L. goodei* along the west coast, *Jordanella floridae* in Alligator river, *Molliensia latipinna, J. floridae, L. goodei, F. seminolis* in Peace river, *Jordanella* in Hillsboro river and *M. latipinna, J. floridae, L. goodei,* and *F. ocellaris* in Withlacoochee river. None of these did he find in the Santa Fe river not far from the southern edge of the Okefinokee swamp. The Okefinokee swamp in its fish contents is decidedly fluviatile and hence the few species in our list. If, however, it be not rich in species it is teeming in individuals — small killifishes as a general food resource for the animals of the swamp and larger basses and catfishes as food for man.

Only two collections of fish have been made in Suwannee river previous to our trip of 1912, one by W. J. Taylor at Nashville, Georgia, Allapaha river, a tributary of the Suwannee river and west of the Okefinokee; the other, by Albert J. Woolman at Santa Fe river in Bradford county, Florida, to the south of the Okefinokee. The first collector took [19] *"Poecilichthys quiescens, Notropis metallicus, Elassoma evergladei,* and other interesting species." In this collection were two new forms, *Notropis metallicus* Jordan and Meek and *Zygonectes zonifer,* Jordan and Meek (this latter now considered a male *Fundulus nottii*). The minnow was not taken by us. Of the Woolman collection, he himself writes as follows: [23] "The Santa Fe River is an eastern, and one

of the largest tributaries of the Suwanne River. Collections were made at three places on this river and its tributaries, in Bradford County.

"*The Santa Fe River* is the outlet of a lake of the same name, situated in the southeastern part of Bradford County. This lake is about 11 miles long, 5 miles wide, and very deep. Three miles southwest of Hampton, a station at the crossing of the Georgia and Southern Florida and the Florida Central and Peninsula railroads, the river is only about 20 feet wide, with an average depth of about 4 feet. Here the river follows through woodland, and is full of cypress trees, coarse grass, and algae. A red alga, Batrachospermum, was found in such abundance at this place as to hinder the use of seines. The examination was made January 3, 1891; water temperature, 49°F.

"*Sampson Creek* is a small northern tributary of the Santa Fe, and is very shallow. It afforded very few fishes. It was examined at Sampson, January 5, 1891; water temperature, 49°F.

"*New River* is a large northern tributary of the Santa Fe, and at the place where it was visited, New River Station, was of about the same size and character as the Santa Fe, but the water was more shallow. The bottom is sandy and black, the banks are low, and the vegetation extends down to and into the water. Fishes were not abundant. Examined January 5, 1891; water temperature, 50°F."

Woolman [23] secured sixteen species, three of which were not taken by us. These sixteen are:

Ameiurus natalis	Heterandria ommata
*Noturus gyrinus	Aphredoderus sayannus
*Noturus leptacanthus	Chaenobryttus gulosus
Erimyzon sucetta	Lepomis punctatus
*Notropis roseus	Lepomis pallidus
Gambusia patruelis	Lepomis megalotis
Zygonectes chrysotus	Etheostoma quiescens
Zygonectes nottii	Elassoma evergladei

Satilla river to which Little Okefinokee swamp is tributary is to the immediate east. At Waycross, Bollman [10] in June, 1889, collected the following, one species of which was missing from our collection:

*Notropis roseus	Elassoma evergladei
Gambusia patruelis	Lucius reticulatus
Aphredoderus sayannus	Labidesthes sicculus
Lepomis pallidus	Etheostoma fusiforme
Lepomis punctatus	

Thus we have added to our list, *Notropis mettalicus, Notropis roseus, Schilbeodes gyrinus* and *Schilbeodes leptacanthus,* or mem-

bers of the *Cyprinidae* and *Siluridae*. These two families with Percidae (darters) furnish most of the hypothetical species which follow in a later list.

In the same publication Bollman's collections from Ogeechee river are reported. These are from a more remote locality yet might suggest some of the forms which might make a hypothetical list. The forms secured in this river and not recorded in our Okefinokee area by us or by others are:

Ameiurus platycephalus	Chologaster cornutus
Notropis chalybaeus	Lepomis auritus
Notemigonus c. bosci.	Etheostoma nigrum olmstedi
Opsopoedus emiliae	Etheostoma nigrofasciatum
Opsopoedus bollmanni	Etheostoma squamiceps

In the Altamaha river basin (Ockmulgee and Oconee rivers) far to the north of the swamp Jordan and Brayton [17] and Jordan [13] report the following species not found in the swamp:

Ameiurus brunniens (platycephalus)	Codoma callisema
Lepomis auritus	Ceratichthys rubrifrons
Hadropterus nigrofasciatus	Ceratichthys biguttatus
Boleosoma maculaticeps	Semotilus corporalis
Nothonotus inscriptus	Myxostoma cervinum
Alburnops amarus	Myxostoma papillosum
Hydrophlox lutipinnis	Ichthaelurus punctatus
Codoma xaenura	Ameiurus marmoratus

Strictly speaking we suppose the Florida group should be added to the hypothetical list, namely:

Jordanella floridae	Lucania goodei
Fundulus seminolis	Fundulus henshalli
Ameiurus erebennus	Ameiurus okeechobensis

Possibly a few of the coastal species might enter the swamp, to wit:

Fundulus ocellaris	Heterandria formosa
Molliensia latipinna	

The following freshwater species have also been recorded from Florida, namely: [18]

Ameiurus catus	Eupomotis holbrooki
Moxostoma aureolum	Lepisosteus tristœchus
Pomoxis sparoides	Lepisosteus osseus
Cliola vigilax	

Thus, we have a list of thirty-eight species of which several darters and minnows are least likely to occur in the swamp because they require different conditions, and are taken in rapid clear waters. Furthermore, if all these thirty-eight with our present twenty-eight species occurred in the swamp it would give sixty-six species or fifteen more freshwater forms than are recorded from Florida. Our Okefinokee list including the records

of others includes the following twenty-eight species (starred forms are in our collections):

*Lepisosteus platostomus
*Amiatus calva
*Ameiurus natalis
*Schilbeodes gyrinus
Schilbeodes leptacanthus
*Erimyzon sucetta
Notropis roseus
Notropis metallicus
*Anguilla chrysypa
*Umbra limi
*Esox americanus
*Esox reticulatus
*Gambusia affinis
*Fundulus cingulatus
*Fundulus nottii
*Lucania ommata
*Aphredoderus sayannus
*Labidesthes sicculus
*Elassoma evergladei
*Centrarchus macropterus
*Enneacanthus obesus
*Chaenobryttus gulosus
*Lepomis megalotis
*Lepomis heros
*Lepomis punctatus
*Lepomis pallidus
*Micropterus salmoides
*Boleichthys fusiformis

Almost all of these include more or less widespread species. As pointed out above the distinctive so-called Florida forms are absent and no coastal species are recorded. The killifishes are represented by four species, the basses by eight species, the catfishes by three species and the darters by one species while in the hypothetical list the minnows are twelve in number, the killifishes seven, the basses three, the catfishes six and the darters four. Truly in number of species the swamp is a disappointing place and in no way comparable in this respect with the better known Everglades of Florida. Twenty-eight freshwater species compare not very favorably with the fifty-one freshwater forms of Florida. When a more systematic study of the fishes of the swamp is made and more varied localities within it and outside of it are worked then we may expect a more pretentious list. The new records ought to include more catfishes, minnows and killifishes.

Since this paper was submitted a visit to the swamp was made in the summer of 1921. Additional evidence in support of the conclusions reached was secured. Another visit will be made during the summer of 1922.

The more important observations of this paper are:

1. That Umbra limi (Kirtland) should include U. pygmaea De Kay. (pp. 362-364).
2. That the southern limit of the range of Umbra limi (Kirtland) is materially increased from North Carolina to southern Georgia. (p. 362).
3. That Esox americanus (Gmelin) should include E. vermiculatus Le Sueur. (pp. 364, 365).
4. That Lucania ommata (Jordan), a rare species redescribed, is abundant in the Suwannee River basin. (p.).
5. That Enneacanthus obesus Baird should include E. gloriosus (Holbrook). (pp. 368-370).

6. That our material strengthens the contentions of Smith,[22] McKay [21] and Bollman [4] that the genera Apomotis and Eupomotis should be included within the genus Lepomis. (pp. 371-373).
7. That the length of the pectoral fin is not of taxonomic importance in the separation of these supposed genera. (pp. 372, 373).
8. That Boleichthys fusiformis Girard should include Copelandellus quiescens (Jordan). (pp. 373-375).
9. That Fundulus cingulatus Cuvier and Valenciennes and Fundulus nottii (Agassiz) are of a group of nine (Zygonectes) forms which may some day be assembled into two or three forms. (pp. 365, 366).

Lepisosteus platostomus Rafinesque.

Short-nosed Gar, "Gar."

The occurrence of gars in the swamp is, according to the natives, not common. Inasmuch as these fishes favor freer water than is found in the swamp this was to be expected. The same natives report one at Mixon's Ferry over four feet in length and one at "Lop-a-Hawl river" (Allapaha river) about five feet in length. If these records are correct and we have no reason to question the veracity of these natives, this might be the Alligator Gar, *L. tristoechus,* because *L. platostomus* is supposed to have a maximum length of three feet. We have three specimens taken in 1912, 1914 and 1917.

Amiatus calva Linnaeus.

"Mud-fish" "Black-fish"

The very nature of the waters of Okefinokee swamp would lead one to expect to find this sluggish-water form in a list of its fish inhabitants. Strangely enough, it has not been given in lists of collections from definite localities near Okefinokee. General summaries of its range, however, note its presence from Florida to Virginia and from Minnesota to Texas; Smith [22] considers it abundant in North Carolina. We secured three specimens and in the stomach of one we found a warmouth.

Ameiurus natalis Le Sueur.

"Mud Cat," "Yellow Cat," Catfish, Cat.

The question of catfishes in Okefinokee is complicated by the reports of forms collected in neighboring regions as well as by the descriptions of natives and of authors. One might expect to find a number of species in the swamp in view of the large number reported as occurring nearby. Five species of Ameiurus are reported from North Carolina, namely: *A. catus, A. erebennus, A. natalis, A. nebulosus,* and *A. platycephalus.* Ten-

nessee river is reported as having *A. melas* and *A. natalis*. Alabama river has the same species and Savannah river has *A. catus* and *A. platycephalus*. Florida has quite a diverse collection, *A. nebulosus* being reported from Peace river; *A. natalis* from Hillsboro, Withlacoochee and Santa Fe rivers and *A. erebennus* being described originally from St. John's river. It is evident from this that *A. natalis* would be the most probable inhabitant of the swamp and we identify the eighteen specimens which we have as belonging to that species.

The specimens which we have vary in length from nine to fourteen inches but the comparative measurements are remarkably uniform.

Parasites and *enemies*. The bodies of all of the fish were opened and examined for parasites. Eight of these had a nematode parasite inside of the body cavity. Besides these internal enemies, catfish have to contend with other inhabitants of the swamp. A large southern water snake, *Natrix s. fasciata* (Linne) was examined and found to contain an eleven inch catfish. Our notes show that catfishes and warmouths are caught more commonly than other species of fish by the natives and that these form a large proportion of the food of the people living in the swamp.

We examined the stomachs of each of the specimens with the view of obtaining data on the food habits. Many of the stomachs were empty. The others contained food ranging from decayed animal matter to freshly caught insects and fishes and crustaceans. One of the most interesting stomachs contained three catfish spines, the pectorals being about the same size as those of the fish which had eaten them.

The natives describe four species of catfishes in the swamp. One of these the "Mud Cat" gets to be almost two feet in length. We believe this to be *A. natalis*. They also describe a "Blue Cat" which they claim to be blue all over. It has a forked tail and is sometimes called "Forked-tailed Cat." Inasmuch as *A. catus* is reported from regions about Okefinokee and the description is not unlike that of this species, it seems highly probable that *A. catus* occurs in the swamp. The other two forms which they describe are not so easily disposed of. Neither their "Channel Cat" or "Toad Cat" has a forked tail. The former is described as having a round tail with specks along the body. Inasmuch as they call this form "Blue Cat" we infer that the main color is blue. The other, the "Toad Cat" squeals when it comes from

the water, and is black with blue specks. It reaches a length of about a foot and a half. Inasmuch as color seems to be an inconstant character in catfishes it would seem to be a poor criterion for species separation. The habit of squealing has been ascribed to *A. nebulosus*. This species is also reported as being highly variable in color, in some cases being mottled, and we are inclined to believe that *A. nebulosus* may occur in the swamp. At any rate subsequent expeditions would do well to investigate the catfish problem.

Schilbeodes leptacanthus (Jordan).

Woolman [23] secured three small specimens in New river, a large northern tributary of Santa Fe river.

Schilbeodes gyrinus (Mitchill).

Tadpole Cat.

Woolman [23] reports it as rare in the Santa Fe proper and in Sampson creek of the Santa Fe. Several specimens were taken by us in 1921.

Erimyzon sucetta Lacèpéde.

Mullet, Creek Fish, Chub Sucker, "Sucker."

Two specimens were collected by Jackson Lee and F. Harper. Previous to the times we secured them, the natives had reported a "sucker" in Billy's Lake which they said was over a foot long and had large scales. Our specimens which were sent out later prove their contention. This species evidently is not at all abundant and does not rank high as a food fish.

Notropis roseus Jordan.

Woolman [23] found this form rare in Santa Fe river and remarked that in this place it was becoming less abundant than farther south. Gilbert [10] reported it as one of the most abundant minnows in the lowland streams of Georgia. It was obtained by Bollman in "Ogeechee River, and Satilla River, and was everywhere common." This may account for Jordan and Evermann's [18] note that it is "the commonest species in the Okefinokee swamps" which may or may not be true.

Notropis metallicus Jordan and Meek.[19]

This minnow was described from seven adult specimens taken "by W. J. Taylor in a tributary of the Altamaha (Suwannee) River, at Nashville, Ga." Jordan and Evermann [18] corrected

the evident mistake and made it "the Allapaha — a tributary of the Suwannee River."

Anguilla chrysypa Rafinesque.

"Fish Eel," Eel.

We have no specimens of the eel but the natives describe it sufficiently well to warrant its inclusion in the list. They always termed it "fish eel" in contrast with the "snake eel" (*Amphiuma means*) and recognized its true fishlike characters. Occasionally they catch eels two feet long or more. It is considered uncommon in Billy's Lake and other deeper bodies of the swamp and a few have been reported from Suwannee river proper, according to the residents along it. (A specimen was collected by us in 1921.)

Umbra limi (Kirtland).

Mud Minnow, Dog-fish.

Smith [22] reports *Umbra* from a few localities in North Carolina and it is supposed that these localities mark the southern limit of the range of the family in America. Our specimen (8591) from the swamp therefore unquestionably increases the range of the genus.

In Jordan and Evermann's [18] account of the two American species *U. limi* (Kirtland) and *U. pygmaea* DeKay, it seems that the latter is "perhaps a variety" of the former though "no intermediate forms have been noticed." They distinguish between the two species primarily on the basis of coloration. *Umbra limi* is described as having a faint precaudal bar while that in *U. pygmaea* is distinct. The lower jaw in *U. limi* is pale in contradistinction to the black lower jaw of *U. pygmaea*. The color of *U. limi* is *dull* olive green while *U. pygmaea* is *dark* olive green and the former has pale cross bars while the latter has longitudinal streaks. *Umbra limi* is described as having pale longitudinal streaks as well as the cross bars but it is evident that the two species are quite close together. The question is complicated further by Gill [9] who in his monograph on the genus differs from Jordan and Evermann [18] in claiming that *U. pygmaea* is *light* olive green and *U. limi* is *dark* olive green. He mentions the longitudinal and vertical stripes as distinguishing characters but otherwise his descriptions of the two species are almost exactly identical. In summing up the situation then we have two authors who note very small differences between their species and who do not agree with each other in their comparison. Furthermore

the distinguishing characters are based on coloration, a character which is admitted to be variable.

In view of the situation the material from Okefinokee, coming as it does from a hitherto unknown station, should prove of interest. We are unfortunate in that only one specimen of *Umbra* was collected. This was 2 inches long or 1¾ inches exclusive of the caudal. (Additional specimens were collected in 1921.) The jaws are not produced and are nearly equal. The lower one is if anything slightly longer than the upper. In these characters and in body measurements our specimen agrees most closely with the description of *U. limi,* the Western Mud Minnow, which is supposed to range from Quebec to Minnesota and south to Ohio river.

In regard to color, we find it difficult to place our specimen in the already established species. The color is, to be sure, olive green to brown, the color being deeper at the caudal extremity of each scale. The dorsal part of the body is, if anything, darker than the ventral but it would be difficult to describe the whole body as "dark" or "dull." If anything it is both. The gill covers are lighter in color than any other part of the body exposed in a lateral aspect. There is absolutely no indication of transverse stripes or vertical bars and it would seem to us that such characters are not sufficient to separate a species, particularly when both characters may appear in a given form. Gill [9] figures specimens of *Umbra* in which both streaks and bars are present. He does not himself name the species. There is a precaudal black bar with a fainter bar at the base of the fin, such as has been ascribed to both species. In our specimen this precaudal bar is very distinct, thus making the specimen agree more closely with the description of *U. pygmaea.* The lower jaw, on the other hand, agrees with that of *U. limi.* It is very pale beneath and dark but not *black* at the margin. The fins are slightly lighter in color than the body.

To sum up our findings, we would say that our specimen resembles *U. limi* in the body measurements and in the intensity of color of the precaudal bar. It has a lower jaw much like that of *U. pygmaea* and the range of *U. pygmaea* would lead us to expect it rather than *U. limi* in Okefinokee. Our specimen differs from the descriptions of both *U. limi* and *U. pygmaea* in regard to the lateral and vertical bars and stripes and inasmuch as Jordan and Evermann [18] and Gill [9] differ in regard to which species is the darker we cannot use this character effectively to any extent.

We are inclined to believe that Jordan and Evermann [18] are right in supposing that the *U. pygmaea* of De Kay is possibly a variation of *U. limi* (Kirtland) and in proposing that the two be grouped under the one species *U. limi* (Kirtland).

Esox americanus (Gmelin).

"Jack-fish," Banded Pickerel.

A study of the literature of *Esox americanus* (Gmelin) gives one a variety of concepts of the species. It is very similar to and we believe identical with *E. vermiculatus* Le Sueur. This opinion has been held by one of us for at least ten years. Apparently the main difference between the two supposed species is that *E. americanus* is always found east of the Alleghenies while *E. vermiculatus* is always found west of that range. To add to the confusion, we find that Gilbert [11] in writing of the Escambia river basin states that Hawkins creek, one of its tributaries, is the "easternmost record" for *E. americanus* while Jordan and Evermann [18] state that Escambia river is the "westernmost record" for the same species. Added to this, we find Bean [3] quoting Professor Cope as finding *E. vermiculatus* in Susquehanna river, although he adds that it is probably not native there.

Aside from the range, there is confusion in the descriptions of these species. Jordan and Evermann's [18] descriptions of the two differ primarily in that the head of *E. americanus* is 3 3/5 in length and the head of *E. vermiculatus* 3 1/4; the snout of *E. americanus* is 2 1/2 while that of *E. vermiculatus* is 2 1/5 in the head. They mention one supposedly clear cut difference, describing the eye of *E. vermiculatus* as "being exactly in the middle of the head; middle of eye nearer tip of chin than gill opening." This is manifestly a physical impossibility and can be of no value in comparison with *E. americanus* which has the "posterior margin" of the eye "scarcely behind the middle of the head, its middle nearer tip of chin than gill opening." The eye of *E. americanus* is described as being 2 2/3 in the head and that of *E. vermiculatus* as 2 1/2.

A composite of the measurements of these two species from five sources, (D. S. Jordan and B. W. Evermann,[18] T. H. Bean,[3] H. W. Fowler,[8] H. M. Smith,[22] and S. A. Forbes and R. E. Richardson [7]) shows the following:

	E. americanus	*E. vermiculatus*
Head measurements.....	3 + -3 3/5	3 1/5-3 1/2
Snout measurements.....	2 1/2-2 2/3	2 1/5-2 9/10
Eye measurements...	5 1/2-7	5 1/2-6 4/5

A glance at the above makes it evident that the head, snout or eye of *E. vermiculatus* may be larger or smaller than that of *E. americanus*. The characters are of little value. Our ten specimens show the following measurements: H. 2 5/6-3 1/5, Sn. 2 1/2-2 3/4, E. 5 1/2-7.

The fin formulae for the two species are identical or overlapping. Previous descriptions give the following: *E. americanus*, D. 11-14, A. 11-12; *E. vermiculatus*, D. 11-12, A. 11-12. Our specimens have D. 12-14, A. 11-13.

The color characters used to determine the species are almost invariably qualified as "usually", "sometimes", "about", "obscurely", "not distinctly" and the color is described as being "extremely variable." In view of this fact we can see no basis for recognizing two species on color characters alone, when color is so tricky in this genus, as many know who have worked with young of *E. lucius* and *E. reticulatus* and with adults of supposed *E. americanus* and *E. vermiculatus*.

An examination of the food of our ten specimens reveals crayfish and killifish as the major sources of prey.

Esox reticulatus (Le Sueur).

"Jack-fish," Green Pike, Chain Pickerel, Common Eastern Pickerel, Jack.

Only five specimens of this species are in our collection. While we were in the swamp the Lees caught several fine "jackfish." When the water is high this species is one of the forms which these people capture by "striking", a night method of fishing in the overflowed crossways and edges of the islands.

Fundulus cingulatus Cuvier and Valenciennes.

The recorded range of this form is from South Carolina to Florida. Our Okefinokee series of this species consists of ninety-five specimens of sixteen different collections. It is one of the most widespread species of the swamp and vies with Gambusia for the premier honors in abundance. Woolman [23] found it common in Santa Fe river of this same basin.

The difference between descriptions of *Fundulus chrysotus* Holbrook and *Fundulus cingulatus* Cuvier and Valenciennes in head, depth and eye measurements are so slight as to be non-distinctive.

This species was common in all the prairies and in every little pond or swampy spot in the islands or in transient pools which

very quickly come and go. Like the other killifishes it is one of the main foods of the pikes, gars, and other fish carnivores of the swamp.

Fundulus nottii (Agassiz).

"Star-head Minnow," "Star-head."

It has been taken from South Carolina as well. In the Suwanee river basin, Woolman [23] took it in Santa Fe river to the south of the swamp and Jordan and Meek [19] describe it from Allapaha river, Nashville, Georgia, as *Zygonectes zonifer*.

We have only six specimens which might well be considered *F. nottii*. The natives know it as the "Star-head" and it is not uncommon in the swamp. The six longitudinal bands are very prominent and in most specimens the ten to twelve vertical bands are very obscure if not absent. One specimen (8714) has the coloration of *Fundulus zonifer* (Jordan and Meek) the types of which Taylor secured at Nashville, Georgia, in Allapaha river, a tributary of the Suwannee river system as is the Okefinokee swamp.

This Fundulus material shows how easily one might think of *Fundulus nottii* and *Fundulus zonifer* as intensely marked female and male *Fundulus dispar*.

These creatures are surface fishes of the prairies and have as associates *Lucania ommata, Fundulus cingulatus* (*chrysotus*), *Gambusia affinis*. This order is about the inverse of their relative abundance as revealed by our collections and observations. Our few specimens show the form to be widespread in the swamp.

Lucania ommata (Jordan)

We have sixty-three specimens of this rare form in thirteen different collections from the swamp. A description of this material has been reported [24]

Gambusia affinis Baird and Girard.

"Minnow" "Pieded Minnow."

This species ranges from Delaware to Mexico, along the Atlantic and Gulf coasts and is found in sluggish waters, brackish or fresh water indiscriminately. It is included in almost every fish list from these regions. In Florida, it has been collected from Escambia, Alligator, Peace, Hillsboro and Santa Fe rivers. Our series includes 283 (198 females and 85 males) forms which were collected in every month of the year and in most diverse places of the swamp.

In our material the dorsal is 7-9; anal 8-11; scales 29-34. The proportion of males to females in the whole 283 specimens was a little more than two females to one male, a high ratio of males as compared with most collections. In several separate collections when both sexes were taken they were about even, in others the ratios varied from one female to two males through two to one, three to one, to six and one-half to one. In some instances only females or males were collected. Very few of the females have the characteristic black spot above the vent. The presence or absence of the suborbital spot seems to be more or less independent of sex. We cannot agree with the statement that forms "from dark-colored water of swamps" are "with a distinct purple bar below eye." [22] Many of our specimens are without the suborbital spot. In Dr. Smith's figure of the male the caudal is represented as plain but some of our males have the three or four dark bars similar to the caudal of the female.

There was a group of ten mottled forms and we saw many of them in the swamp ("pieded minnow" of the natives). The whole side of body and fins is heavily blotched with black, the blotching being most notable on the caudal half of the body and on the caudal fin. At first we thought it might be a sexual character but six are males and four are females. Of this phase Löennberg [20] writes, "In some places certain varieties are predominant for instance Gambusia *patruelis* forma *melanops* in Lake Beauty not far from Orlando. This lake has rich vegetation and rather dark water. In clay springs and the sulphur springs round Lake Jessup melanistic forms were not scarce. It seems to be many more males than females struck by this melanismus which probably at least partly is due to the chemical composition of the water." The sexual suggestion does not apply in our material. These ten come from open prairies (Honey Island and Floyd's Island prairies), dense cypress ponds and other diverse places, also associated with normal forms. Peculiar localities or chemical composition of water cannot sufficiently explain it. These specimens certainly are of *Gambusia affinis* and are much more melanistic than those upon which Cope based his description of *Haplochilus melanops*.

In the middle of June we took several females with very advanced embryos and each female had from sixteen to twenty-five embryos. Some of the largest females in total length reached five or six centimeters.

Aphredoderus sayanus (Gilliams).

Pirate Perch.

Two specimens of the Pirate Perch were collected in the Okefinokee swamp.

Labidesthes sicculus Cope.

Brook Silverside, Skip-jack, Glass-fish.

Two specimens were taken at Mixon's Ferry, Suwannee river, June 18, 1912. These were taken by "striking" with a bush knife. F. Harper secured another on Chase Prairie, January 12, 1917.

Elassoma evergladei Jordan.

Pigmy Sunfish.

This diminutive species was collected at thirteen different times at various places in Okefinokee swamp.

This small fish is common on the islands, in cypress ponds, in hammocks, in crossways between islands and in more or less sphagnous bogs. At first we frequently mistook it for the young of a Centrarch.

Centrarchus macropterus (Lacèpéde).

"Shiner," "Sand Perch," "Sand Flirter," Flier.

Forty-eight specimens of this species of the Centrarchidae were collected in Okefinokee.

It is evidently abundant locally. It is reported in lowland streams and still waters from Virginia to southern Illinois and South to Louisiana and Florida.

Chaenobryttus gulosus (Cuvier and Valenciennes).

"Warmouth," "Perch," Goggle-eye.

We collected two specimens. The stomachs of these specimens were examined. The contents were however, badly mutilated. There seemed to be quite a quantity of mud mixed with crayfish claws in each case.

This species probably is the most common food fish of the swamp.

Enneacanthus obesus Baird.

Spotted Sunfish.

It is rather remarkable that our collection includes twenty-six specimens of this small and very beautiful sunfish. This is remarkable because of the fact that in lists of fishes collected from neighboring streams but two specimens of members of the genus

have been reported. These come from Ogeechee river and one of the specimens is assigned to the species *obesus* while the other is classified as *gloriosus*. We believe that these species are synonymous and offer the following data to prove our contention.

We are not, however, the first to suggest this synonymy. Witness the following quotations. Abbott,[1] speaking of *E guttatus* and *E. obesus* says,—"We have very carefully searched for a trait characteristic of this fish as compared with *E. obesus* and have uniformly failed to do so." He allows them to retain their identity as species because they had "never been found associated." "The similarity of the two species," he says, "is so marked that unless living they can scarcely be distinguished," and considering the abundance of one and the scarcity of the other he suggests that *E. obesus* is washed down, occupies certain streams and drives out *E. guttatus*. He says that they are always found in streams with an unobstructed access to rivers. Holbrook,[12] in his descriptions of *Bryttus fasciatus* and *B. gloriosus* seems to separate them on the fact that the upper margin of the eye in the former is near the facial outline but does not encroach upon it while in the latter the upper margin of the eye is one-half the diameter of the orbit from the facial outline. By this token we would place all of our specimens in *B. fasciatus*. In his description of the dorsal fin of these two species he claims a formula of IX, 12 for *B. fasciatus* and IX, 11 for *B. gloriosus*. None of our specimens possess a dorsal formula of more than IX, 11 and all but five, (8654), (8655), (8647), (8639) possess a IX, 10 dorsal. The anal according to the same source is III, 11 in *B. fasciatus* and III, 10 in *B. gloriosus* and in our specimens but two have as high as eleven soft rays while nearly one-half of the remainder possess less than ten. Fin formulæ then would indicate that our specimens were *B. gloriosus*. Jordan and Evermann [18] claim that *E. obesus* and *E. gloriosus* are closely related but *apparently* not intergrading. They differ from Holbrook[12] as to the dorsal and anal formulæ thus adding weight to an argument that these are variable and consequently not of sufficient taxonomic importance to separate species, particularly on the basis of one or two soft rays. They separate the species on the grounds that the opercular spot of *E. obesus* is more than one-half the size of the eye while in *E. gloriosus* it is smaller. On this basis our seven largest specimens would all be *E. obesus* except (8640) and (8659) (mutilated). Otherwise, these two specimens are not

greatly dissimilar from the other larger specimens. Jordan and Evermann [18] place *E. guttatus* (*Pomotis guttatus* Morris) and *E. obesus* as synonyms. *Bryttus fasciatus* is also given as a synonym of *E. obesus*. On the basis of the arguments given above we would place *E. gloriosus* also as a synonym.

Our specimens range in size from a specimen (8658) nine-sixteenths of an inch long to two specimens (8639) and (8640) 3¼ inches long. Our description of the species will be based for the most part upon Nos. (8652), (8644), (8639) and (8640). These specimens we believe include most of the variations represented by the collection.

The table below summarizes some important data on seven of the twenty-three specimens collected.

DATE	No.	ANAL FIN	LENGTH	DEPTH	HEAD
June 18-20, 1912.....	8644	III, 9	2	2	3
June 24, 1912.....	8641	III, 9	2¾	2	3
June 15-Nov., 1912.....	8659	III,10	incom.	2½	2½
June-Nov., 1912.....	8660	III,10	1½	2—	2½
July 15-Nov., 1913.....	8652	III,10	1⅜	2½	2½
Jan. 1-Oct. 1, 1914.....	8640	III,10	3¼	1 4/5	2⅔
Jan. 1-Oct. 1, 1914.....	8639	III, 9	3¼	2¼	2⅔

It is interesting to note that using head measurements we would place (8640) under *E. obesus* and (8639) under *E. gloriosus* which is exactly the opposite to the classification which would be made on the basis of the opercular spot.

The fins of the species of *Enneacanthus* are very prominent but vary through such a short degree that they are not of great taxonomic importance.

Unfortunately our preserved specimens cannot give us much information as to the color of the body. Considerable variety is present, however, and in most cases there is a rather pronounced tendency for from six to ten vertical bars to appear on the sides. These bars are for the most part dark olive brown. Between these bars and in those forms without the bars the body is light olive brown.

Lepomis punctatus Jordan

"Stump-knocker," "Log Perch," Brim.

One specimen was collected at Billy's Island, June 6 to 7, 1912. The body is almost oval in form, the depth being contained

two times in the length, and it is strongly compressed. The profile is quite steep before and behind and there is a slight depression above the eye. The dorsal profile is much more strongly arched than is the ventral.

The head is short and deep and is contained three times in the standard length. It tapers quite abruptly to the snout and is so compressed that its greatest width is contained 1¾ times in the length. The snout is contained 3½ times in the length of the head. The lower jaw is slightly longer than the upper and the mouth is set obliquely. In our specimen, there is no supplemental maxillary bone and this character would exclude our specimen from Jordan and Evermann's [18] interpretation of the genus *Apomotis*. Bean and Weed,[2] however, proved in the case of *Lepomis holbrookii* that the presence and absence of the supplemental maxillary was not of taxonomic value. Our specimen adds further proof to their contention. Inasmuch as this is the principal basis for the separation of the two genera we contend with Bollman and others that *Apomotis* and *Lepomis* should be combined under the name of the latter. The maxillary extends to a distance one-third through the eye. We are inclined to agree with Boulenger [5] who states that the rakers are short, and to differ from Jordan and Evermann [18] who describe them as "rather long, stiff and strong."

The ventral fins extend slightly beyond the source of the anal. In this respect our specimen differs from the description given by others. They do not reach the anal and are uniformly light brown to dusky. The caudal fin is dusky and only slightly emarginate.

Lepomis megalotis (Rafinesque).

"Redbreast," Long-eared Sunfish.

In spite of the fact that Smith [22] remarks that North Carolina is the southern limit of the range of this species, we found it in Okefinokee.

Lepomis pallidus Mitchill.

Blue gill Sunfish.

The general distribution of this species is from the Great Lakes region south to Texas and Florida.

The one specimen, (8635) which we have in our collection was sent out by the Lees in 1914. The palatine teeth are absent and the lower pharyngeals are broad and concave. The teeth on the lower pharyngeals are pointed not paved or rounded and this should place our specimen in the genus *Lepomis* not *Eupomo-*

tis, providing, of course, the latter genus should retain its identity. An excellent figure of the pharyngeal teeth of this species is given by Bean and Weed.[2] The width of the pharyngeal teeth is contained 2½ times in the toothed portion or midway between the two of *Eupomotis* and the three of *Lepomis* which Forbes and Richardson [7] use to separate the genera.

The fins are quite characteristic and have been used by some for taxonomic purposes. Boulenger [5] for instance separates his genera *Lepomis* and *Eupomotis* on the ground that the pectoral fins of the former are rounded and those of the latter pointed. By this token, our specimen would come under the genus *Eupomotis.* We have found already, however, that it has the pharyngeal teeth of *Lepomis.* We are not surprised then to find Boulenger [5] combining *Lepomis pallidus* and *Eupomotis pallidus.* We would think it advisable, however, to have placed them under the genus *Lepomis* rather than under *Eupomotis.* We notice that Smith,[22] McKay[21] and Bollman[4] combine the three genera *Apomotis, Eupomotis* and *Lepomis* under the one genus *Lepomis.* Our specimen, which has the pectoral fin of Boulenger's [5] *Eupomotis* and the pharyngeal teeth of *Lepomis,* should add weight to the advisability of combining at least two of these genera. Bean and Weed [2] were unable, unfortunately, to obtain specimens of the so-called *E. pallidus* when making their notes on the pharyngeal teeth of *Lepomis.* We believe that this may be due to the fact that, as Boulenger suggests, they are synonymous and, together with other writers already mentioned, we believe that the genius *Lepomis* proposed in 1816 should include the genus *Eupomotis* proposed in 1860. Our grounds for this, based on our specimen, are summarized as follows: It has pharyngeal teeth such as are ascribed to the genus *Lepomis* by Bean and Weed.[2] It has a pointed pectoral such as is ascribed to the genus *Eupomotis* by Boulenger.[5] It has the width of the toothed portion of the pharyngeals 2½ or midway between the width of two for *Eupomotis* and three for *Lepomis* which Forbes and Richardson [7] use as a criterion.

Lepomis heros (Baird and Girard).

"Bream," Pumpkin-seed Sunfish.

Two specimens of this species were collected June 24, 1912, at a cypress crossing one-half mile from camp. This species is not generally considered as common and the range given for it by all authors classifies it as a southern form.

As in other sunfishes of the *Apomotis, Eupomotis* and *Lepomis*

group one finds considerable ambiguity and difference of opinion as to the characters best describing the species.

The palatine bones are without teeth and the lower pharyngeals are broad and slightly concave. The teeth on the lower pharyngeals are rounded at the top not pointed as in *L. pallidus*. This characteristic, according to Jordan and Evermann,[18] should place our specimens in the genus *Eupomotis*. Other characters which others ascribe to the genus do not, however, agree with our specimen. Bean and Weed [2] figure the pharyngeals.

The fins, which have been of considerable taxonomic importance, are here interesting because they do not always agree with descriptions given. Boulenger [5] states that the pectorals are acutely pointed in the genus *Eupomotis* and not in *Apomotis* and *Lepomis*. By that token our specimens are *Eupomotis*. Jordan and Evermann [18] say that the pectorals of *Eupomotis* are longer than the head in all species except in *E. pallidus* and Forbes and Richardson [7] claim that the pectorals of *E. heros* reach to a vertical from the base of the last anal while in *E. gibbosus* they scarcely reach the front of the anal. Since the pectorals are shorter than the head and do not reach beyond the insertion of the anal and since the scale formulæ of our specimens do not agree with those of either *E. pallidus* or *E. gibbosus* it is patent that there must be some trouble. Since our specimens agree with the description of *Lepomis heros* Jordan and Gilbert in practically every respect other than those mentioned above it is believed that our specimens belong to that species. Our specimens show, then, that the length of the pectorals may be variable and consequently is not of the taxonomic importance placed upon it by some.

Micropterus salmoides (Lacepede).

"Trout," Large-mouthed Black Bass.

In our whole stay within the swamp (1912) we saw none of this species nor have the Lees sent us out any specimens. Just before our entrance into the swamp we saw some nice examples of "trout"(one foot long) which were caught in Suwannee river at Fargo where we were assured they were not uncommon. (This species was quite commonly collected by the party in 1921.)

Boleichthys fusiformis (Girard).

Darter.

The descriptions of this species are very confusing. We show in the discussion below conflicting statements not only in the de-

scription of *Boleichthys fusiformis* but in the original descriptions of *Poecilichthys quiescens* Jordan or *Copelandellus quiescens* Jordan [15] which appears in the Proceedings of the United States National Museum for 1884, page 478, together with the description of the same species which appears in Jordan and Evermann's Fishes of North America, page 1100. It was with some hesitancy that we compared these descriptions, but when it was all done the evidence against the separation of *Copelandellus* from *Boleichthys* was so strong that we are convinced that the former is a synonym of the latter. The most striking differences did not occur between the descriptions of *Boleichthys fusiformis* and either species description of *Copelandellus* but rather between the two separate descriptions of *Copelandellus.*

An examination of the characters given in these descriptions should show that the main differences between *Boleichthys fusiformis* and *Copelandellus quiescens* are that the former has a naked area on top of the head and a maximum of X spines in the dorsal while the latter has the top of the head scaled and a maximum of XII spines in the dorsal. If we are to believe the descriptions given by Jordan and Evermann [18] for *B. fusiformis* it is manifest that the scalation about the head is variable, for we read, "opercles, nape and breast usually well scaled, *sometimes* partly naked." Since this is a variable character it would seem to us unwise to separate species or genera fundamentally upon such characters. If the descriptions of other characters were consistent, we might be more prone to recognize *Copelandellus* but Jordan and Evermann's[18] description is at variance with Jordan's[15] original description to such an extent that one must question the accuracy of observation or the interpretation used. It is evident that there must be error when we read that the body is extremely elongate and not greatly elongate; the gill membranes are separated and yet united; and that there is a black humeral spot and no black humeral spot. Added to this is the assertion that the anal fin is finely barred and yet plain.

The presence of a maximum of XII spines in the dorsal of *Boleichthys* is easily accounted for. The original description of *Copelandellus* was made from a single specimen which may have had twelve spines. We believe this to be exceptional as of seven specimens collected by Woolman,[23] six had nine and one ten. Even if XII spines is characteristic of *Copelandellus* it should not be

sufficient to separate it from *Boleichthys* for if we interpret Fowler's [8] formulæ correctly we find him attributing XII spines to *Boleichthys fusiformis.*

An examination of the figures of the two supposed forms should convince one of their identity, providing, of course, that the figures agree with the descriptions. Smith [22] places the two figures on opposite pages so that a comparison is simple. One of the characters which is considered as common to the two supposed species is the vertical rows of four spots at the base of the caudal and yet neither figure shows this character. *Copelandellus quiescens* is described by Smith [22] as having a barred anal fin and yet the figure omits this character. Our specimens show that the anal may be either barred or not. This is, therefore, not of great importance. Jordan and Evermann [18] describe a broad black lateral band in *C. quiescens* which the figures do not show and which we do not find in our specimens. Smith [22] describes three black bars below the eye in the same species while the figure shows but one large spot. The figures of *Boleichthys fusiformis* are also subject to criticism when compared with the descriptions although these are less noticeable than in *C. quiescens.* The most prominent of these exceptions is the already mentioned absence of vertical rows of spots at the base of the caudal. The species is claimed to be extremely variable by Jordan and Evermann [18] so allowances must be made. It should be evident that this variableness does occur when one attempts to reconcile figures with descriptions and with specimens.

A comparison of our specimens with the descriptions shows that in regard to the number of spines in the dorsal and the absence of scales on the head we should consider the darter of Okefinokee to be *B. fusiformis.* Inasmuch as we believe that we have shown these characters to be variable we regret but believe that *Copelandellus* cannot stand as a separate genus. The descriptions of *Copelandellus* are as variable as in the species *B. fusiformis* and since it is admittedly "an extremly variable form" we suggest the placing of *Copelandellus quiescens* (Jordan) in its synonomy.

We point out that our material comes from the same river system (Suwannee) as the type (Allapaha river, a tributary of the Suwannee) of *Copelandellus quiescens.*

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